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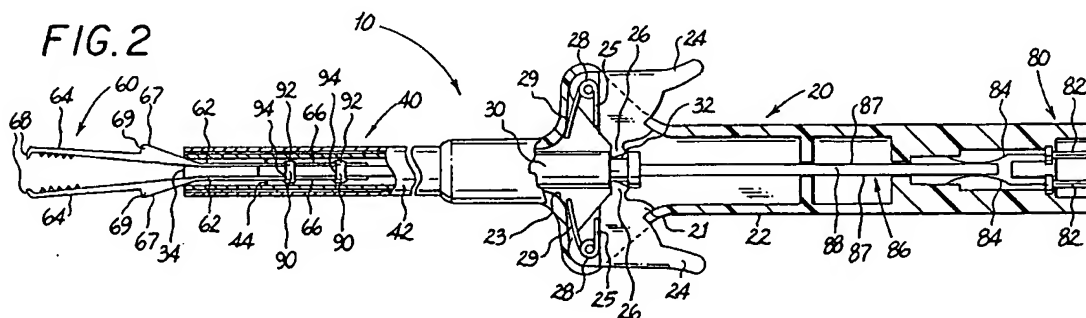
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**DE ES FR GB IT**(71) Applicant: **United States Surgical Corporation**  
**150 Glover Avenue**  
**Norwalk, Connecticut 06856(US)**(72) Inventor: **Scott, Ian M.**  
**20 Marshall Road**  
**Ridgefield, CT 06877(US)**  
Inventor: **Tovey, Jonathan H.**  
**56 Rogers Avenue**  
**Milford, CT 06460(US)**(74) Representative: **Marsh, Roy David et al**  
**Hoffmann Eitle & Partner,**  
**Patent- und Rechtsanwälte,**  
**Arabellastrasse 4**  
**D-81925 München (DE)**(54) **Bipolar surgical forceps.**

(57) The present invention provides a bipolar surgical instrument 10 comprising a handle portion 20, a tool portion 60 for applying electrical energy to tissue cooperating with the handle portion for movement between an open and closed position, electrical connection means 80 for connecting the tool portion to a source of electrical energy having receptacles 82 for

receiving the electrical energy combined with an elongated conductor 86 for transmitting electrical energy to the tool portion, the elongated conductor having first and second conducting paths 87 electrically isolated from one another. The instrument has particular application to endoscopic and laparoscopic surgical procedures.

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## BACKGROUND OF THE INVENTION

### 1. Field of the Invention

The invention relates to bipolar surgical instruments and, more particularly, to bipolar surgical forceps for selectively grasping, manipulating, cutting and/or coagulating body tissue.

### 2. Description of the Related Art

Electrosurgery involves the cutting or coagulating of body tissue by application of high frequency electrical current. In bipolar electrosurgery, the electrical current is applied through an electrode which contacts the body tissue to be treated. A return electrode is placed in contact with or in close proximity to the current-supplying electrode such that an electrical circuit is formed between the two electrodes. In this manner, the applied electrical current is limited to the body tissue held between the electrodes. When the electrodes are separated from one another, the electrical circuit is open and thus inadvertent contact of body tissue with either of the separated electrodes does not cause current to flow.

To perform tissue cutting, coagulation, or a combination thereof, a high frequency power supply is connected to the bipolar instrument. Each electrode of the bipolar instrument is electrically isolated within the instrument and is separately connected to the high frequency power supply. Typical power supplies such as the SSE2L™ available from Valleylab, Inc. of Boulder, Colorado, are r.f. generators which can produce different electrical waveforms to effect various electrosurgical procedures. A waveform of continuous sinewaves alternating from positive to negative at the operating frequency of the r.f. generator is employed to cut tissue. Such a waveform creates short, intense electrical sparks to rapidly heat tissue; cells are exploded and the heat dissipated as steam.

A waveform consisting of pulsating sine waves alternating from positive to negative at the operating frequency of the r.f. generator is employed to coagulate tissue. Such a waveform creates longer, less intense sparks which heat tissue less rapidly, allowing heat to be dissipated more widely than during cutting. A combination of the cutting and coagulating waveforms produces the capability to cut tissue with enhanced hemostasis over the pure cutting waveform.

A fuller description concerning the electrical aspects of electrosurgery can be found in the Valleylab SSE2L™ Instruction Manual published by Valleylab of Boulder, Colorado.

Electrosurgical procedures have, in recent years, become, increasingly widespread. The ease

and speed of cutting and/or coagulating tissue saves the surgeon valuable time while minimizing internal bleeding by the patient. Endoscopic and laparoscopic surgical procedures have created additional incentives for the use of electrosurgical techniques. In laparoscopic procedures, surgery is performed in the interior of the abdomen through a small incision; in endoscopic procedures, surgery is performed in any hollow viscus of the body through narrow tubes inserted through small entrance wounds in the skin. Because laparoscopic and endoscopic surgery does not bring the surgeon into direct contact with the operation site, internal bleeding must be quickly controlled by instruments easily operable from a remote location. Electrosurgical instruments provide the surgeon with the ability to electrically cut tissue such that bleeding is minimized and to effectively seal off bleeders during laparoscopic and endoscopic procedures. Because laparoscopic and endoscopic surgery involve considerable instrument manipulation from a remote location, the actuating mechanism must be convenient to operate once the instrument has been properly positioned.

Thus, a need exists in the art for a bipolar surgical instrument which is readily adaptable for use in laparoscopic and endoscopic surgery. Such an instrument must be capable of compact design for fitting through narrow cannulas. Additionally, the instrument must be conveniently actuated by the user. A need also exists for an instrument which can be easily and reliably manufactured from inexpensive materials for single-use applications.

### SUMMARY OF THE INVENTION

The present invention provides a bipolar surgical instrument comprising a handle portion, a tool portion for applying electrical energy to tissue cooperating with the handle portion for movement between an open and closed position, electrical connection means for connecting the tool portion to a source of electrical energy having receptacles for receiving the electrical energy combined with an elongated conductor for transmitting electrical energy to the tool portion, the elongated conductor having first and second conducting paths electrically isolated from one another.

More particularly, the present invention provides an endoscopic bipolar surgical forceps having a handle portion with at least one actuating handle pivotally mounted to a handle body, first and second forceps legs, each leg constituting an electrode and having a tissue gripping surface adjacent its distal end, an elongated sheath cooperating with the actuating handle to close the forceps, and electrical connection means for providing electrical energy to the forceps comprising an elon-

gated conductor strip having first and second conducting paths separated from each other by an insulator disposed thereon.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the invention are described hereinbelow with reference to the drawings wherein:

Fig. 1 is a perspective view of a bipolar surgical instrument according to one embodiment of the present invention having a pair of actuating handles.

Fig. 2 is a cross-sectional view of the bipolar surgical instrument of Fig. 1 showing the forceps in an open position.

Fig. 3 is a cross-sectional view of the bipolar surgical instrument of Fig. 1 showing the forceps in a closed position wherein only the tissue prongs are in contact.

Fig. 4 is a cross-sectional view of the bipolar surgical instrument of Fig. 1 showing the forceps in a closed position wherein portions of the jaw surfaces are in contact.

Fig. 5 is a cross-sectional view of the bipolar surgical instrument according to a further embodiment of the present invention a pair of actuating handles show the forceps in an open position.

Fig. 6 is a cross-sectional view of the bipolar surgical instrument of Fig. 5 showing the forceps in a closed position.

Fig. 7 is a perspective view of a bipolar surgical instrument according to a further embodiment of the present invention having a single actuating handle.

Fig. 8 is a cross-sectional view of the bipolar surgical instrument of Fig. 7 showing the forceps in an open position.

Fig. 9 is a cross-sectional view of the bipolar surgical instrument of Fig. 7 showing the forceps in a closed position.

Fig. 10 is an enlarged cross-sectional view of the actuating handles of Fig. 1.

Fig. 11 is an enlarged cross-sectional view of the electrical connection portion of the surgical instrument of the present invention.

Fig. 12 is an enlarged cross-sectional view of the connection between the forceps and the conducting strip.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring initially to Fig. 1 there is illustrated in perspective view a bipolar surgical instrument 10 according to a first embodiment of the present invention for application of electrical energy to body tissue. The instrument includes handle por-

tion 20, endoscopic portion 40, forceps portion 60, and electrical connection portion 80.

As shown in Fig. 2, the handle portion 20 combines an elongated hollow handle body 22 with actuating handles 24 pivotally mounted thereto for opening and closing forceps 60. Each handle has a projection 26 extending into the interior of the hollow handle body. Inside handle body 22 sliding sleeve 30 engages actuating handle projections 26 through receiving slots 32. Actuation by the user translates the arcuate motion of handles 24 into longitudinal motion of sliding sleeve 30.

Handles 24 are biased to an open position (Fig. 2) through torsion springs 28 mounted within hollow handle body 22. One leg 29 of each torsion spring contacts interior wall 23 of hollow handle body 22; the other leg 25 of the torsion spring engages a retaining surface within handle 24. When the handles are actuated, legs 29 and 25 are approximated (Fig. 3), placing the torsion springs in compression. Release of handles 24 permits legs 29 and 25 to separate by action of the spring, forcing the handles to their original, open position. Handle stops 21 limit the extent to which handles 24 may open by engaging handle body interior wall 22.

A further embodiment of the bipolar surgical instrument of the present invention which employs a pair of actuating handles is shown in Figs. 5-6. In this embodiment, actuating handles 220 comprise handle heads 224 integral with arcuate handle gripping members 228 for actuation by the user. Handle heads 224 are pivotally mounted to hollow handle body 227 within handle body shroud 222. Similar to actuating handles 24, each handle head has a projection 226 extending into the interior of the hollow handle body where it engages slot 32 of sliding sleeve 30. Actuation of handle gripping members 228 (Fig. 6) causes heads 224 to pivot, sliding sleeve 30 distally as in the previous embodiment.

At their proximal ends, handle gripping members 228 terminate in fingers 240 which are slidably received in handle slots 250. Transverse pins 242 pass through fingers 240 and have projections which engage cooperating grooves within the handle body. During handle actuation, members 228 are flattened (Fig. 6) causing pins 242 to slide proximally within their respective receiving grooves as fingers 240 slide proximally within slot 250.

Handle gripping members 228 are fabricated from a flexible, resilient material, such as polypropylene formed into a living hinge. The use of handle members 228 eliminates the need for metal handle return springs such as the torsion springs of the previous embodiment. When no force is exerted on members 228, they assume their original, arcuate configuration, pivoting heads 224 to their

proximalmost position with stops 221 abutting handle wall 227. Additionally, the elongate configuration of these handles facilitates handle actuation. Regardless of the position in which the instrument is held, members 228 are easily grasped by the user to actuate the handles. The entire handle section may further be encased in a flexible polymeric material such as shrink wrap to protect handle parts and aid in user gripping.

The bipolar surgical instrument can alternatively employ a single actuating handle, as shown in Figs. 7-9 which illustrate a further embodiment of the present invention. Fig. 7 depicts a bipolar surgical instrument 110 having handle portion 120. Endoscopic portion 40, forceps portion 60, and electrical connection portion 80 are substantially the same as those portions of the bipolar surgical instrument depicted in Fig. 1, which will be described below. As shown in Fig. 8, handle portion 120 comprises elongated hollow handle body 122 with actuating handle 124 pivotally mounted thereto for opening and closing forceps 60. The handle has a projection 126 extending into the interior of the hollow handle body. As in the previous embodiment, projection 126 engages a sliding sleeve 130 through receiving slot 132. Torsion spring 129 biases handle 124 to an open position (Fig. 8) and is compressed during handle closure (Fig. 9).

The handles shown and described are representative handle configurations; numerous handle mechanisms may be employed. It will be appreciated that any element capable of providing longitudinal reciprocal motion to sliding sleeve 30 may be used in conjunction with the bipolar instrument of the present invention.

Alternatively, a handle mechanism can be provided which is in communication with the forceps while the sleeve remains stationary. In this configuration, the forceps move proximally and distally into and out of the stationary sleeve by action of the handles for forceps jaw closure.

The endoscopic portion 40 of the instrument includes an elongated tubular member 42 extending distally from handle portion 20. Preferably, the tubular member is fabricated from a biocompatible material such as stainless steel and coated with an insulator to prevent arcing from the electrically live forceps. Gaseous seal means 44 (Fig. 2) in the form of silicone grease or a separate seal block 146 (Fig. 8) are positioned within the endoscopic portion to prevent the escape of insufflating gases used in laparoscopic and endoscopic surgery. Sliding sleeve 30 passes into the endoscopic section tubular member 42 from the handle interior, terminating in sheath edge 34.

Forceps 60 extend from the distal end of endoscopic portion 40 and are used to transmit the electrical energy to body tissue. Forceps 60 com-

prise a pair of elongated forceps legs 62, preferably constructed from a biocompatible, conductive material such as stainless steel. Each forceps leg possesses a tissue-gripping jaw 64 adjacent its distal end. Jaws 64 may be provided with serrated edges for securing tissue therebetween (Figs. 1-4). Alternatively, the jaws may possess smooth tissue-containing surfaces for atraumatic tissue manipulation (Figs. 5-9). Electrical power source connecting regions 66 are located adjacent the proximal end of legs 62. Regions 66 are smooth and flat to facilitate electrical connection.

Each jaw of the forceps may optionally terminate in prongs 68 (Fig. 1); one jaw possesses a centrally-disposed prong while the other jaw possesses two spaced-apart prongs. During jaw closure, the central prong of one jaw slides between the two spaced-apart prongs of the other jaw to ensure proper jaw closure alignment and thus ensure a completed electrical circuit through the desired section of tissue. Additionally, prongs 68 may be used to grip tissue during an electrosurgical procedure or, when the r.f. power supply is inactive, to position tissue as with non-electrosurgical forceps.

Proximal to the jaws each forceps leg has a projection 69 having an angled camming surface 67. As best seen in Figs. 1 and 7, the camming surface 67 is curved. Camming surfaces 67 cooperate with distal edge 34 of sliding sleeve 30 to effect jaw closure. Because sliding sleeve 30 contacts both forceps legs, it must be fabricated from an insulating material of sufficient strength and resiliency to transmit closure force to the forceps jaws. Preferred materials include glass/polymer composites such as glass braid reinforced with epoxy.

When sliding sleeve 30 is pushed distally by handles 24, distal edge 34 travels along camming surfaces 67, approximating the forceps jaws. Prongs 68 are engaged while the surfaces of jaws 64 secure tissue therebetween. Note that in Fig. 3 the forceps jaws do not contact each other except for prongs 68. Further distal movement of the sleeve urges forceps jaws together along a portion of jaw surface 64 as shown in Fig. 4. Thus, the user can select the desired amount of jaw contact area, effecting a variable current density to perform a desired electrosurgical procedure.

The bipolar surgical instrument of the present invention receives power through electrical connection portion 80, located at the proximal end of handle body 22. A pair of receptacles 82 receive leads connected to an r.f. power supply. Although illustratively shown as female jacks, receptacles 82 may take the form of any conventional power connection elements, male or female, limited only by the need for compatibility with the connection ele-

ments of the power supply.

The r.f. power supply to be used with the bipolar surgical instrument may be selected from a variety of those commercially available, such as the SSE2L™ power supply from Valleylab, Inc. of Boulder, Colorado. The SSE2L™ power supply is representative of preferred power sources which include cut, coagulation and blend (a blended waveform of cut and coagulation) modes, offering the user a wide range of electrosurgical options.

Extending distally from receptacles 82 and electrically connected thereto are conducting contact springs 84. Contact springs 84 engage a centrally disposed conducting strip 86 to transmit r.f. power to the forceps jaws. The use of contact springs eliminates the need for conventional solder connections, advantageously simplifying manufacture of the bipolar instrument while increasing its reliability.

Conducting strip 86 provides a pair of conducting paths 87 separated by an insulator 88. Each contact spring and each corresponding forceps leg contacts only one of these conducting paths, maintaining electrical isolation of each forceps leg prior to jaw closure. In a preferred embodiment, conducting strip 86 is fabricated from a printed circuit board, each surface of which is preferably plated with copper and overlaid with nickel to form conducting paths 87; the circuit board itself forms insulator 87. Although conducting strip 86 is shown as flat, other geometries may be readily used. For example, an insulating tube having inner and outer surfaces plated with a conductor to form the two conducting paths may be employed. The shape of the conducting strip will be dictated by the type of tool selected for use at the distal end.

The use of a single element, conductor strip 80, to provide both conductor paths, greatly simplifies instrument construction. Only a single channel, which may be centrally disposed within the instrument, is necessary to supply power to the forceps jaws. Such a configuration facilitates adaptation of the bipolar instrument to endoscopic applications where the working elements must fit within a narrow endoscopic tube. Insulation is simplified since there is no opportunity for individual power-supplying wires to cross one another, short-circuiting the instrument.

Conducting strip 86 extends from the electrical connection portion 80 through sliding sleeve 30 in the handle portion 20, terminating within sleeve 30 in the endoscopic section 40 where it supplies power to the forceps jaws. To connect the forceps legs to the conducting strip and to each other, insulated fasteners are used. In a preferred embodiment, rivets 92 pass through both forceps legs' conducting regions 66 and through conducting strip 86 disposed therebetween. To maintain electrical

isolation of each leg, insulating bushings 94 are disposed about one of each of the rivet's heads such that no portion of the rivet contacts one of the forceps legs and the corresponding conducting path of the conducting strip. The shank of the bushing passes into the insulating portion 88 of the conducting strip through one conducting path, but terminates before contacting the other conducting path of the strip. In this manner, the forceps legs are mechanically, but not electrically, joined. Electrical connection of each forceps leg 62 to a conductor path 87 is made along contact region 66 as fasteners 90 push regions 66 against their corresponding conductor paths.

Although the bipolar surgical instrument of the present invention has been described in terms of forceps, it will be recognized by those of skill in the art that numerous other tool configurations may be used. For example, the forceps may be replaced by tweezers, needles, blades, biopsy cups, or the like. In short, any bipolar electrosurgical tool capable of closure by a sleeve is contemplated. When the selected tool is forceps, the forceps legs may be of unequal size. For example, the forceps leg used as the electrode for supplying power to the tissue may be of small dimensions, thus increasing the current density, while the forceps leg used as the return electrode may be of larger dimensions. Such an instrument provides enhanced cutting capabilities.

The surgical instrument of the present invention may also be used for non-electrosurgical procedures. For example, the r.f. power supply can be turned off or the r.f. power supplying leads may be disconnected from the electrical connection receptacles. Thus, conventional use of a surgical tool, such as forceps, may be made with electrosurgical use optional. Such a capability is advantageous in endoscopic or laparoscopic operations since a change of instruments through the cannula would not be necessary when opting to quickly perform an electrosurgical procedure.

The claims which follow identify embodiments of the invention additional to those described in detail above.

## Claims

1. A bipolar surgical instrument comprising:
  - at least one handle;
  - tool means;
  - movable means extending between said at least one handle and said tool means, said movable means being movable in response to movement of said at least one handle for movement of said tool means between an electrically inactive open position and a closed positions to apply electrical energy to tissue;

and

electrical connection means for connecting said tool means to a source of electrical energy, said electrical connection means having means for receiving said electrical energy, an elongate conductor member cooperating therewith for transmitting said electrical energy, said elongate conductor member comprising at least one insulating member upon which first and second electrically isolated conducting paths are disposed.

2. An instrument as claimed in claim 1 wherein said tool means comprises forceps having first and second legs, each leg constituting an electrode and having means for gripping tissue adjacent its distal end.
3. An instrument as claimed in claim 2 wherein said first forcep leg electrically communicates with said first conducting path and said second forcep leg electrically communicates with said second conducting path.
4. An instrument as claimed in claim 1 wherein said tool means comprises jaw members for gripping tissue, having first and second jaws, each jaw constituting an electrode.
5. An instrument as claimed in claim 4 wherein said first jaw electrically communicates with said first conducting path and said second jaw electrically communicates with said second conducting path.
6. An instrument as claimed in any one of the preceding claims wherein said elongate conductor member comprises a printed circuit having first and second conducting paths.
7. An instrument as claimed in any one of the preceding claims wherein said movable means comprises a slidable sleeve.
8. An instrument as claimed in claim 7 wherein said slidable sleeve comprises an elongate tubular member adapted for use in non-invasive surgical procedures.
9. An instrument as claimed in claim 8 including a gaseous seal disposed within the tubular member.
10. An instrument as claimed in claim 8 or 9 wherein said elongate conductive member extends longitudinally within said elongate tubular member.

11. An instrument as claimed in claim 7, 8, 9 or 10 wherein said at least one handle comprises an actuating handle pivotally mounted to a handle body, said actuating handle having means to engage said slidable sleeve whereby pivotal movement of said actuating handle produces longitudinal movement of said sleeve between open and closed positions.

12. An instrument as claimed in any one of claims 7 to 11, wherein said slidable sleeve includes a distal camming portion adapted to engage angled camming surfaces for aiding in the opening and closing of said forceps in response to movement of said at least one handle.

13. An instrument as claimed in any one of the preceding claims wherein the tool means comprise projections having angled camming surfaces.

14. An instrument as claimed in any of the preceding claims wherein said electrical connection means further comprises contact springs extending from said means for receiving electrical energy for connecting said elongate conductor means to said means for receiving electrical energy.

15. An instrument as claimed in any one of the preceding claims wherein said means for receiving electrical energy comprises a pair of receptacles adapted to connect to an r.f. power supply.

16. A bipolar surgical instrument comprising:  
 an elongate tubular member;  
 at least one handle extending from said tubular member;  
 tool means at least partially disposed within said tubular member and extending from a distal end thereof, wherein movement of said at least one handle moves said tool means between open and closed positions; and  
 elongate conductive means extending longitudinally within said elongate tubular member and having a proximal end for receiving electrical energy from an electrical energy source, said conductive means being positioned at least partially between said tool means.

17. An instrument as claimed in claim 8 or 16 wherein said elongate conductive means is composed of an insulating central portion having first and second electrically isolated conducting paths disposed thereon.

18. An instrument as claimed in any one of the preceding claims, wherein said elongate conductive means is composed of a substantially rigid material.

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19. An instrument as claimed in any one of the preceding claims, wherein said elongate conductive means is substantially planar.

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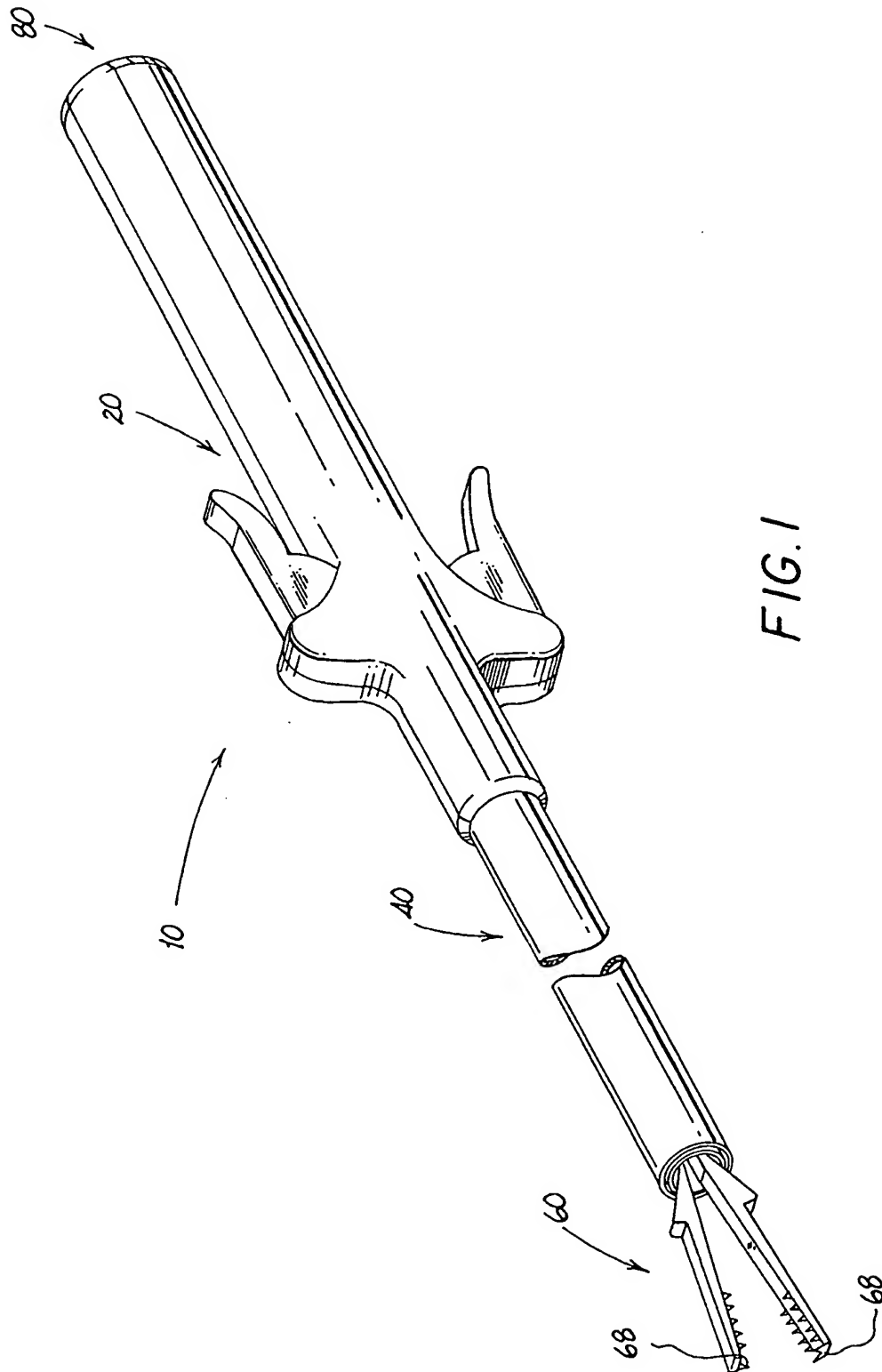
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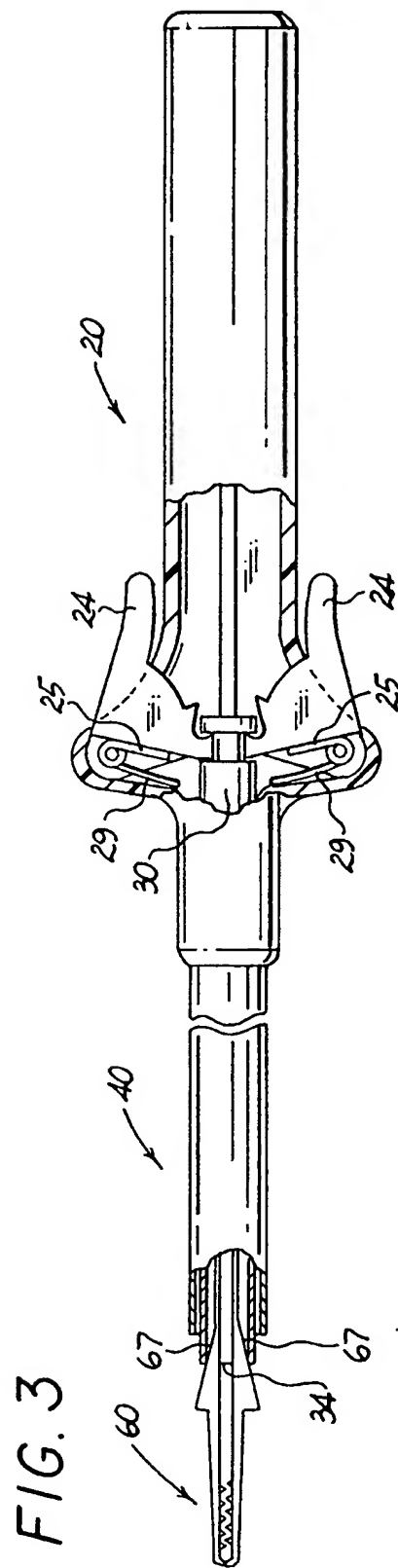
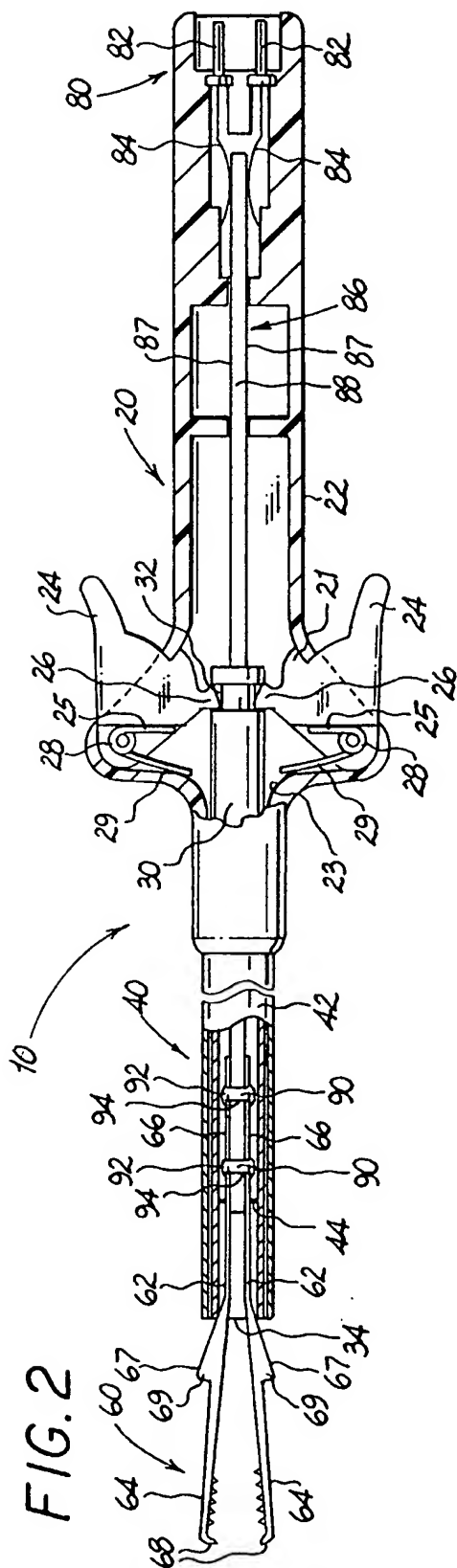
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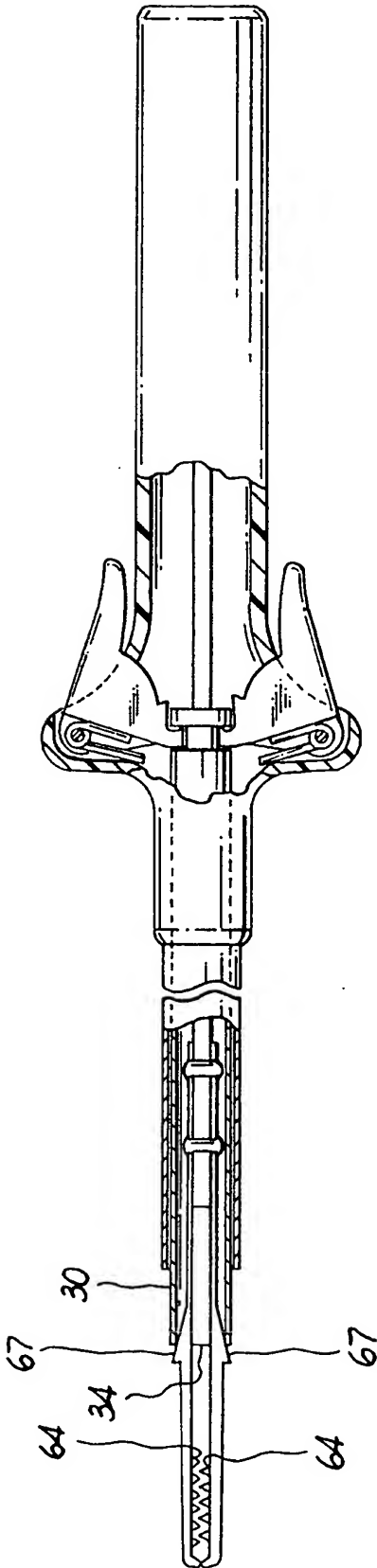
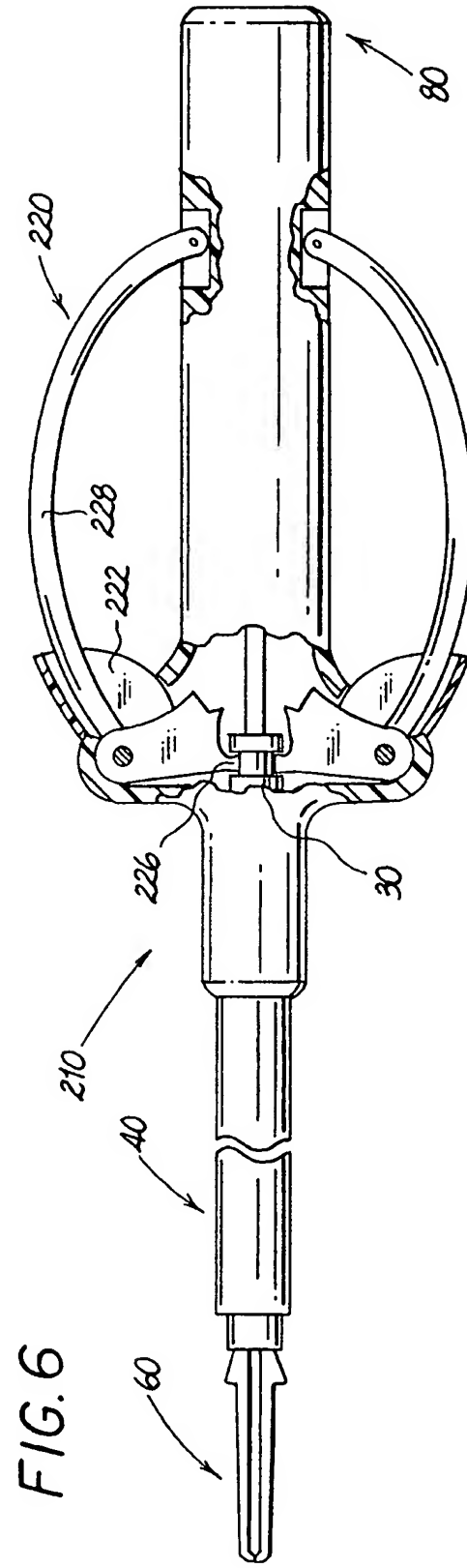
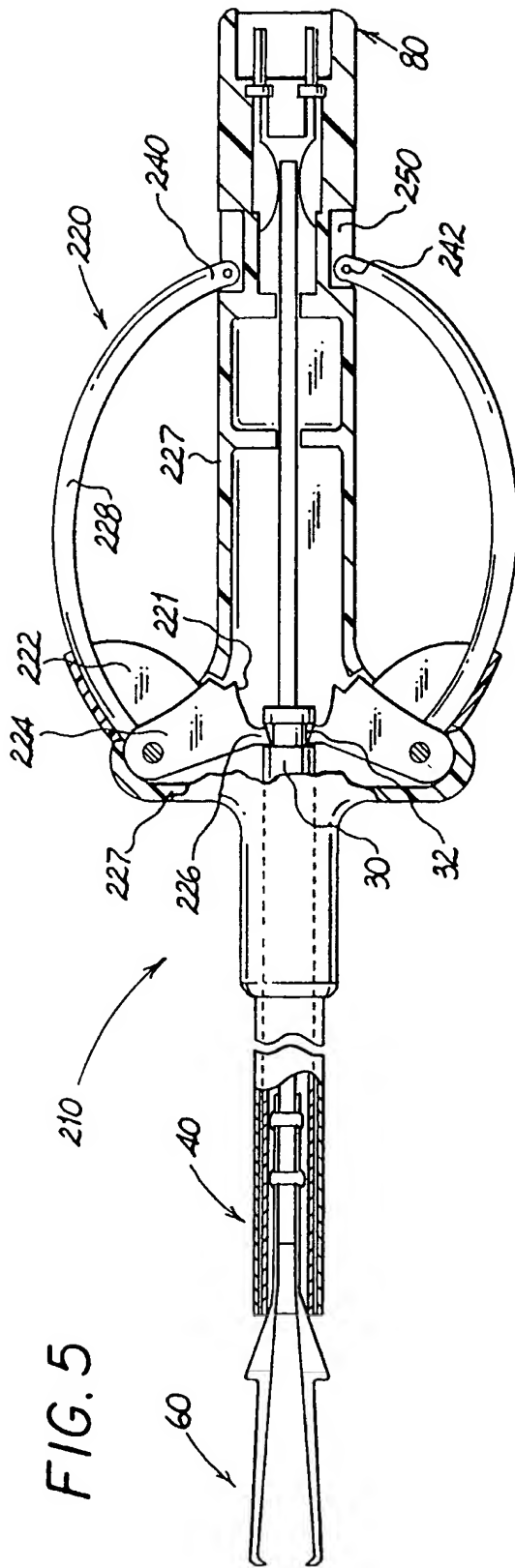
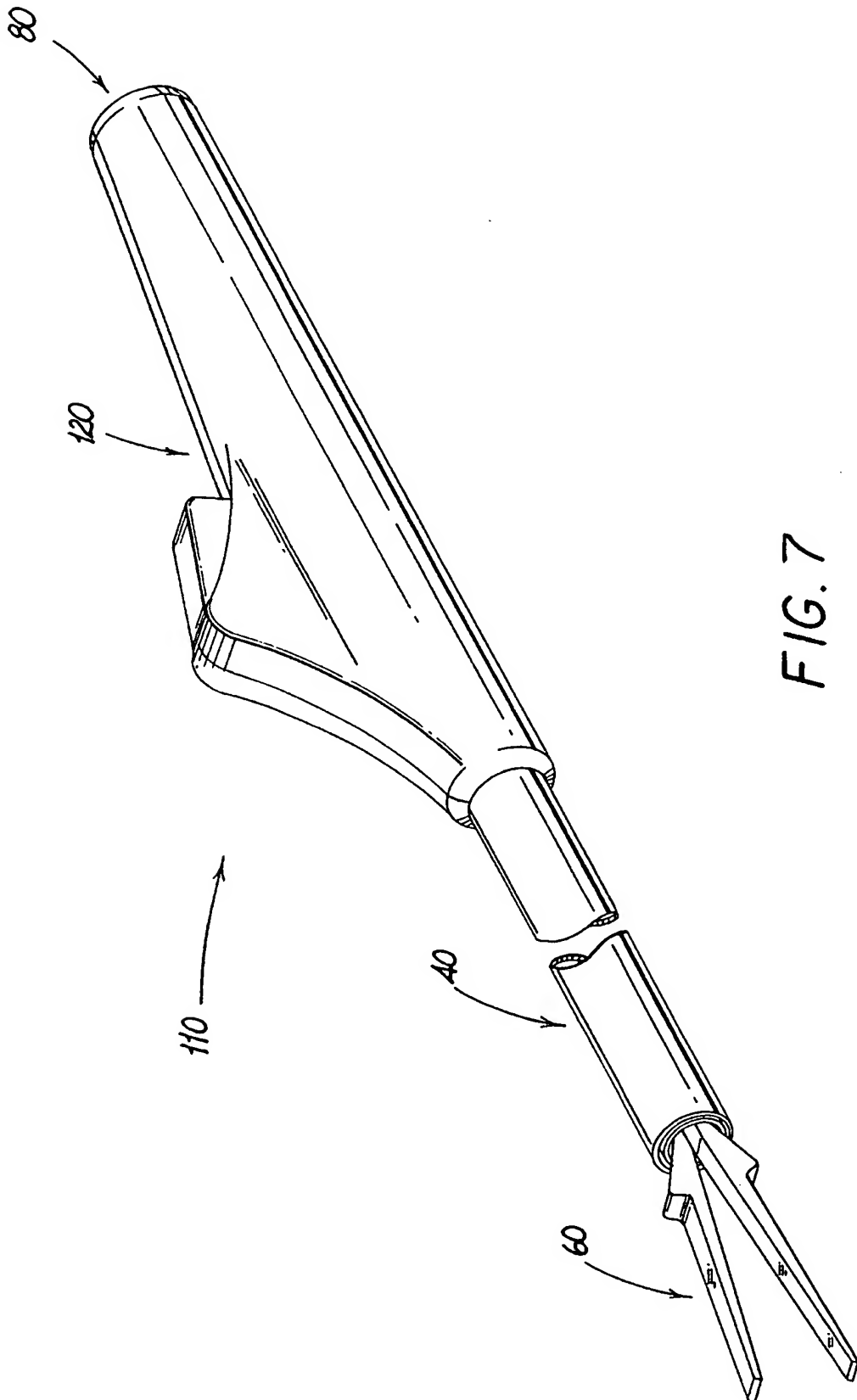


FIG. 4





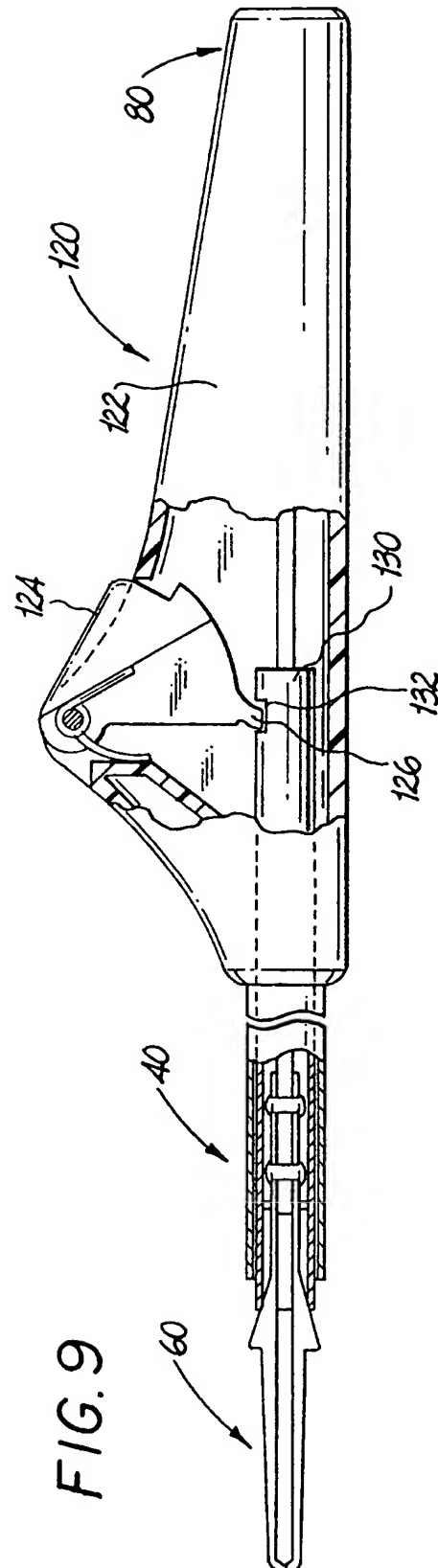
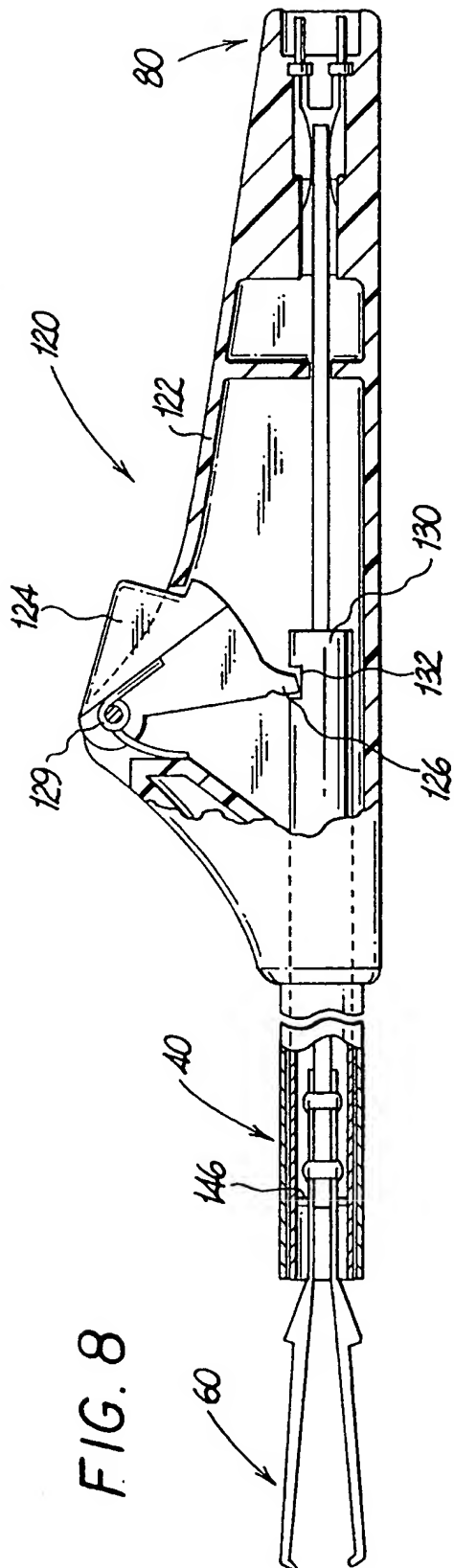


FIG. 10

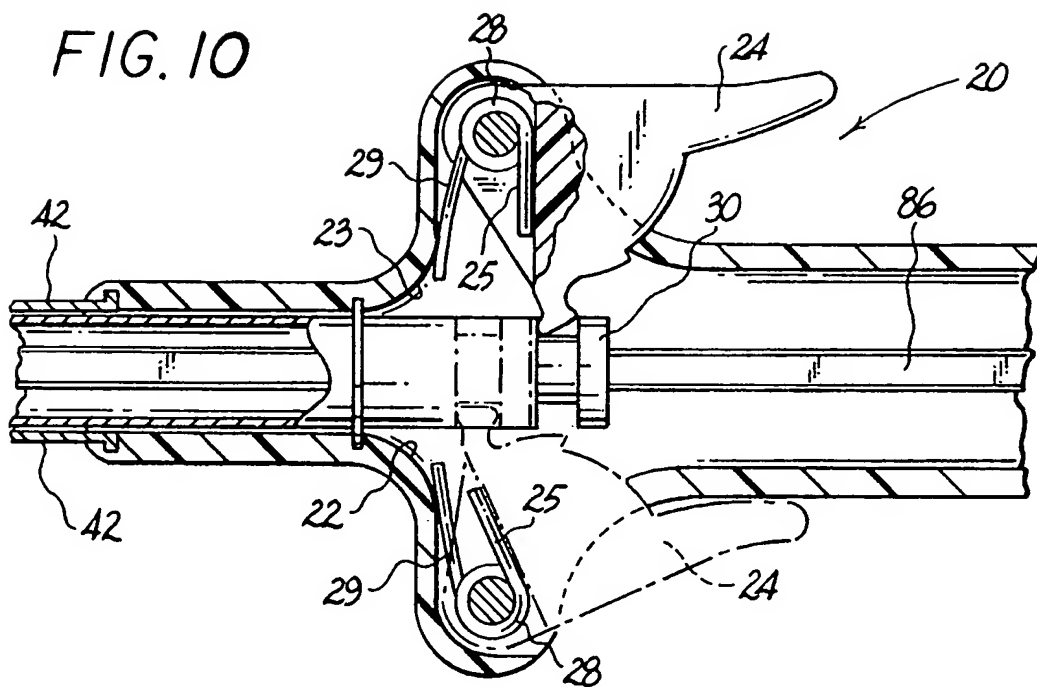


FIG. 11

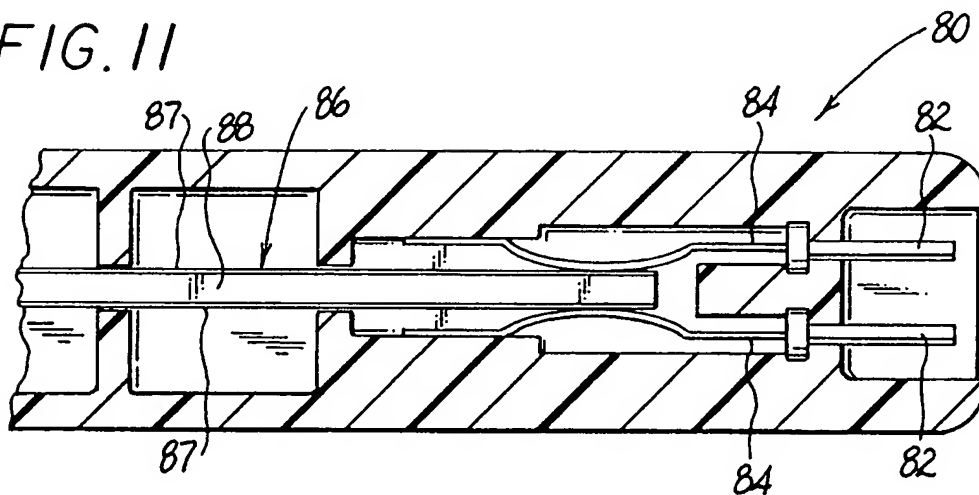


FIG. 12

